Design by Simulation

Notes on the potential of simulation for Architectual Conception

Jelle Feringa

Thanks!

*Iebele Abel
*John Mardaljevic

Design by Simulation

Overview

Introduction
*Computational Architecture in a nutshell
*Computational Chair Design project

Projects
*Seroussi Pavilion
*Sundial

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Computational Architecture

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What is Computational Architecture?

*Applying computation towards architectural conception
*There are no innocent tools
*Moving from a description to a definition
*Hyperrational

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An example of such an approach is the Computational Chair Design project

*Instantiate a design concept rather than parametric design
*Get rid of engineering assumptions / abstraction
*Deal with the design problem in its full resolution
*Integrate fabrication

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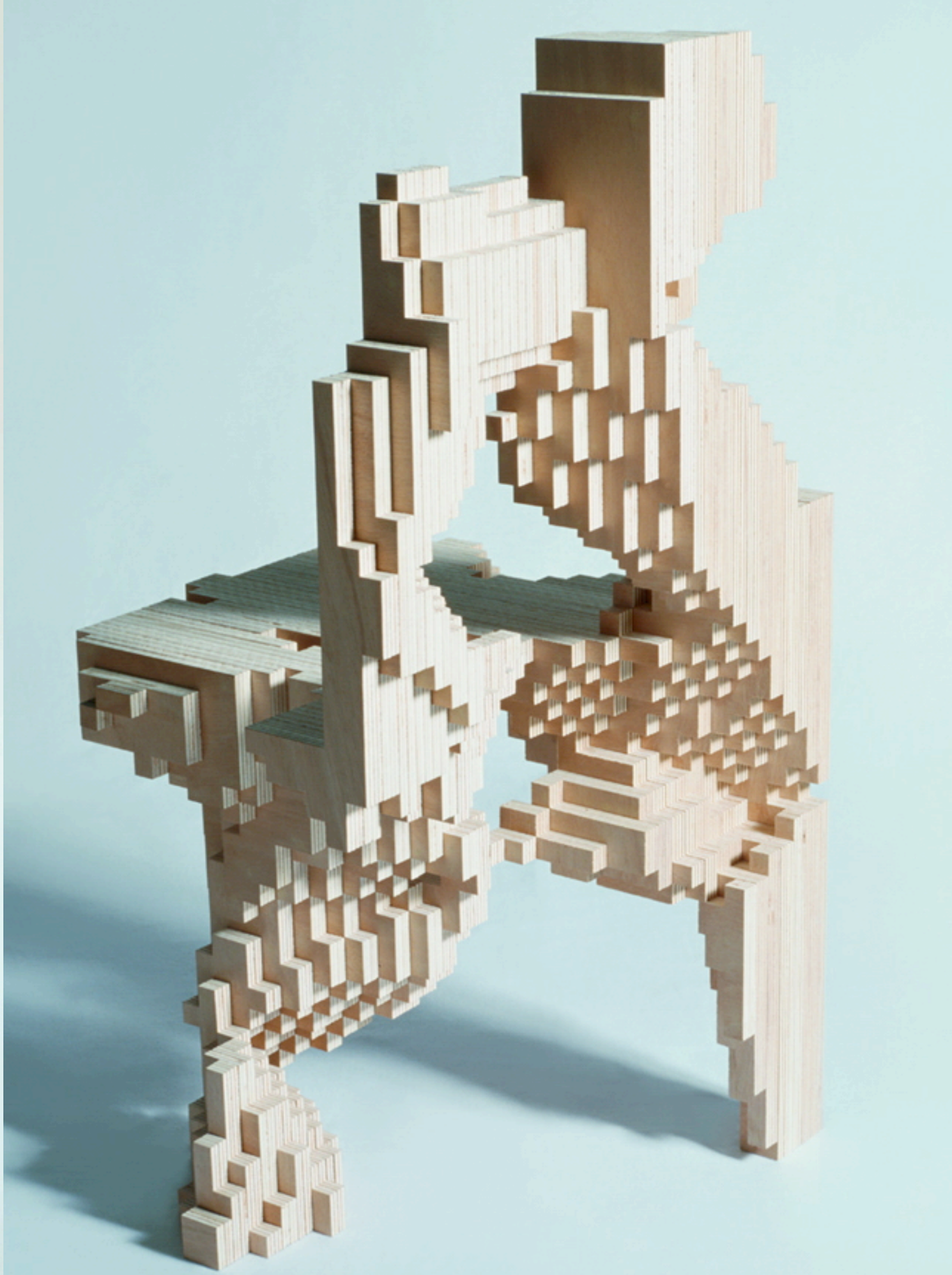
Computational Chair Design project



Computational Chair Design project

Computational Chair Design project

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"Evolutionary computing is the mechanization of the scientific method"

John Holland

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Seroussi Pavilion

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"Elegance is the achivement of maximal effect with minimal effort"

Marcos Novak

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A pavilion illuminated by a homogenous distribution of 200 Lux daylight throughout the year

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RadianceGA

*Locate the architectural program in the domain (embryogeny)
*Partition the domain by a Voronoi diagram
*Evaluate fitness with rtrace
*Run until the design is converged

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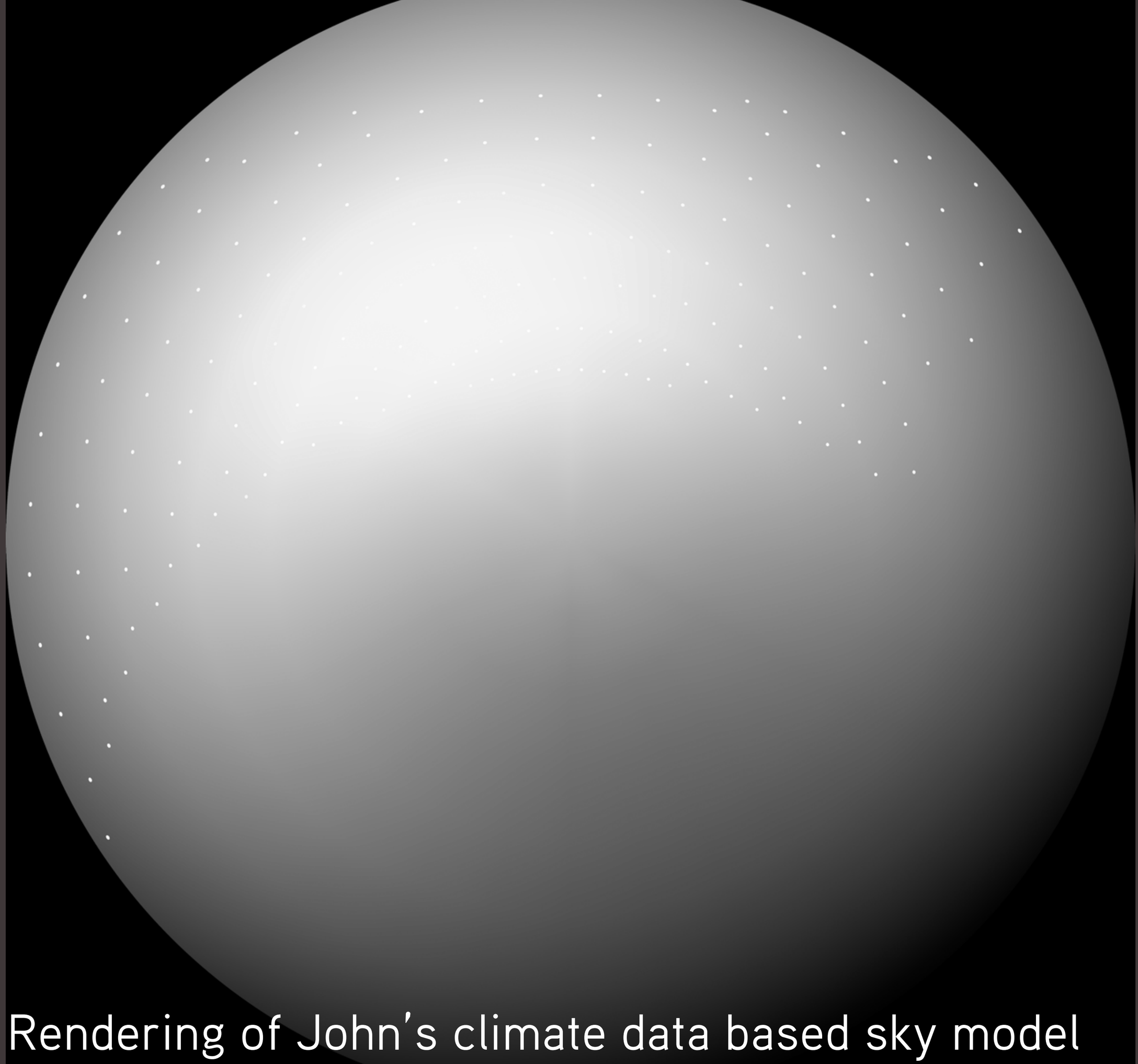
How to simulate daylighting performance throughout the year, throughout the whole day?

Climate data based model by John Mardaljevic



Rendering of John’s climate data based sky model

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RadianceGA implementation

GA
*Genetic Algorithm developed by Marc Schoenauer, based on Evolving Objects
*C++
*returns evolved voronoi sites as input for fitness evaluation
*call python script for fitness evaluation

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RadianceGA implementation

Fitness function
*Python
*CGAL
*Radiance | rtrace

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RadianceGA implementation

Minimize the sum of the delta of the Lux value measured at the center of each cell minus the target value

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How to respect the architectural program?

*Compute the volume for each part of the program
*Select a point to locate the program
*Accumulate Voronoi cells to a point representing the program until the volume necessary is met

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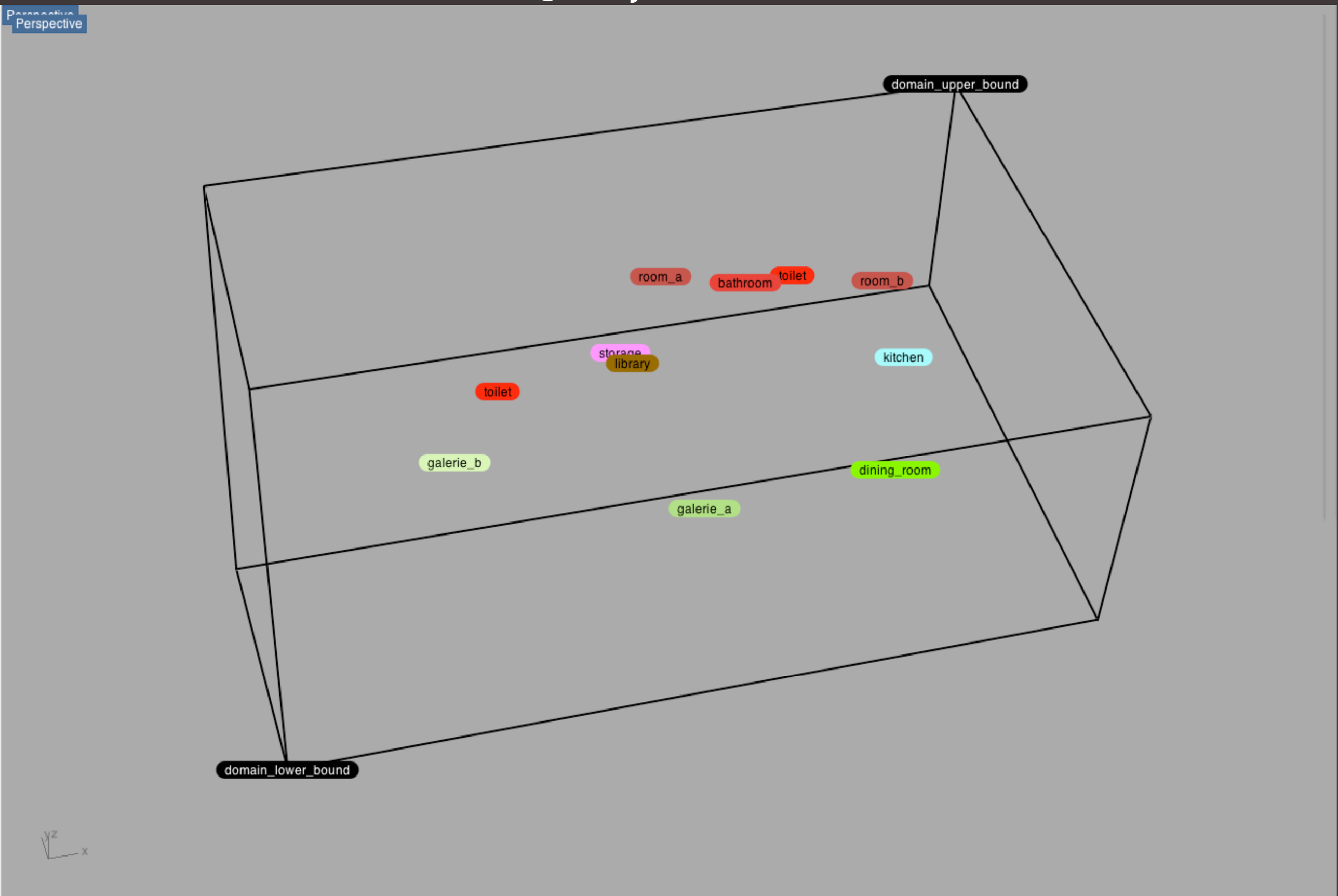
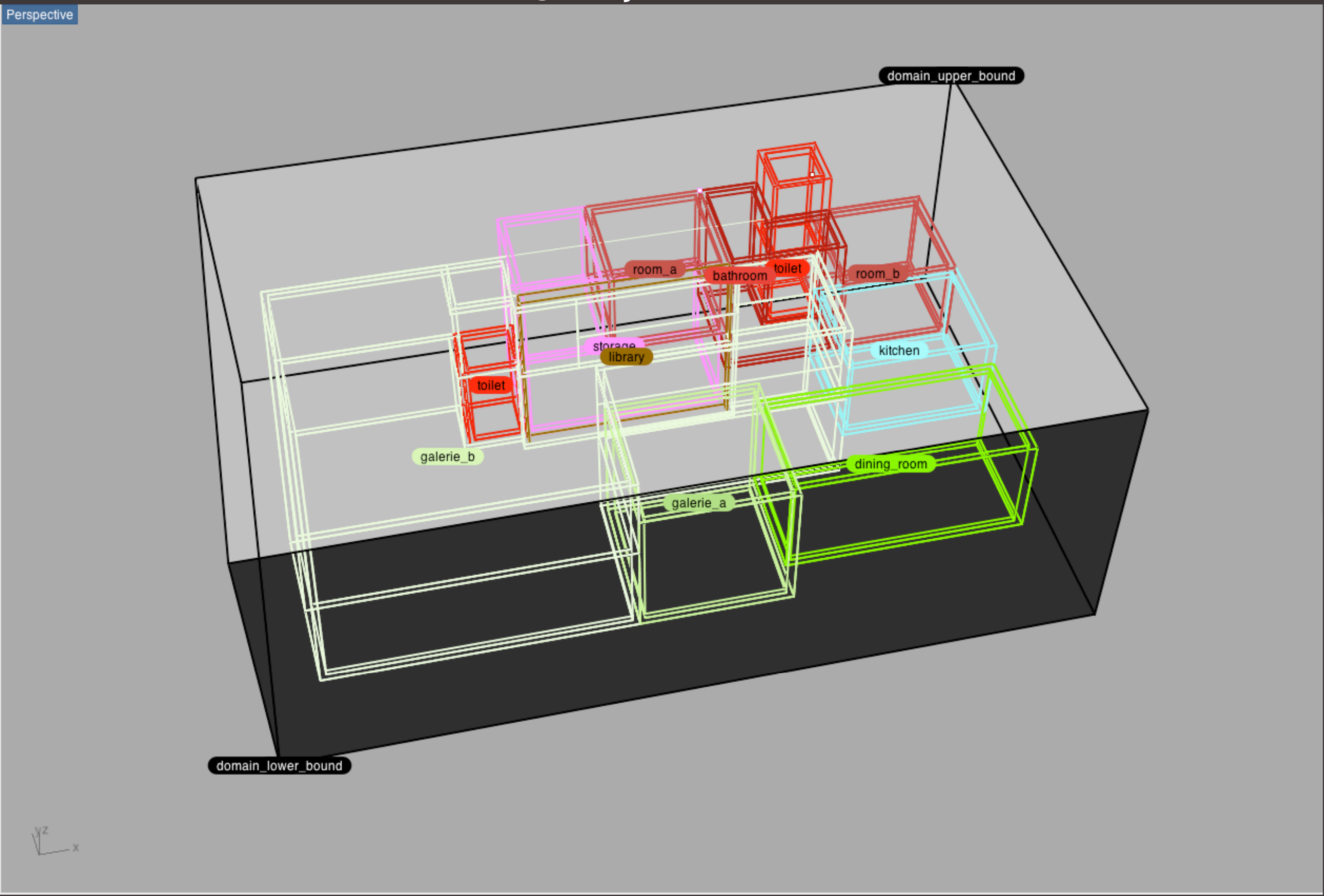


Design by Simulation



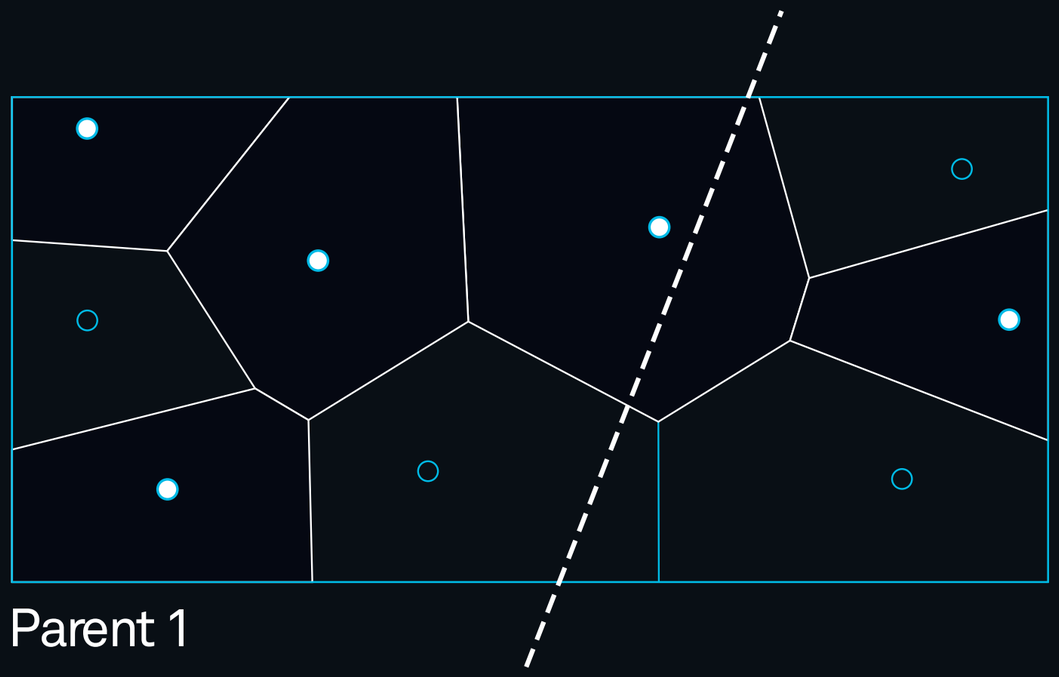
Seroussi Pavilion

Seroussi Pavilion

Seroussi Pavilion

Seroussi Pavilion

Seroussi Pavilion



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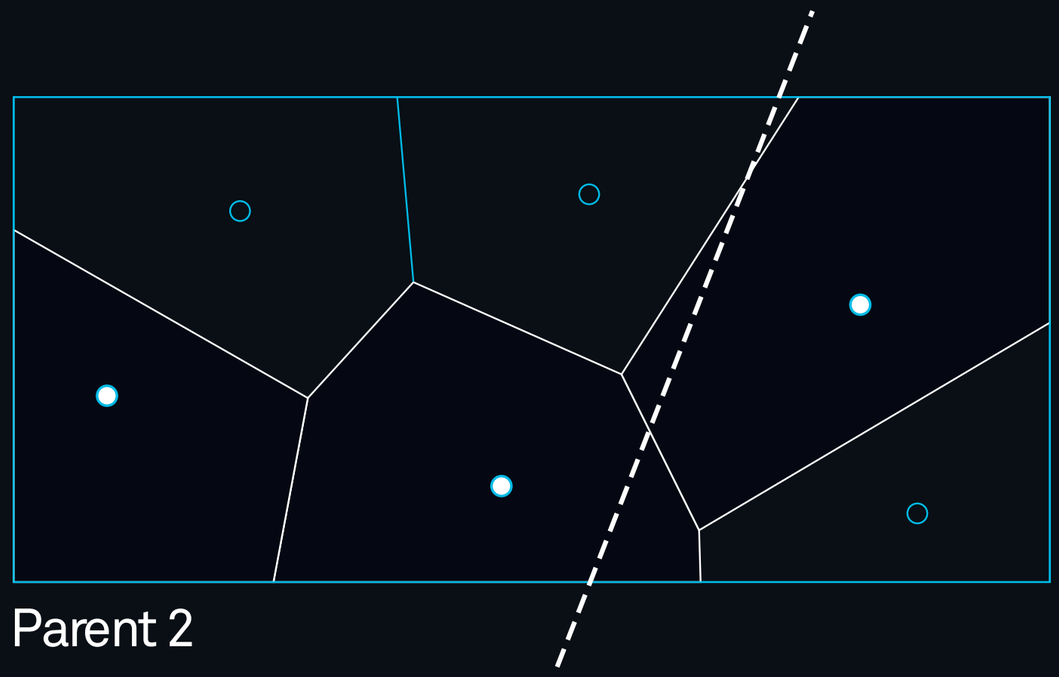

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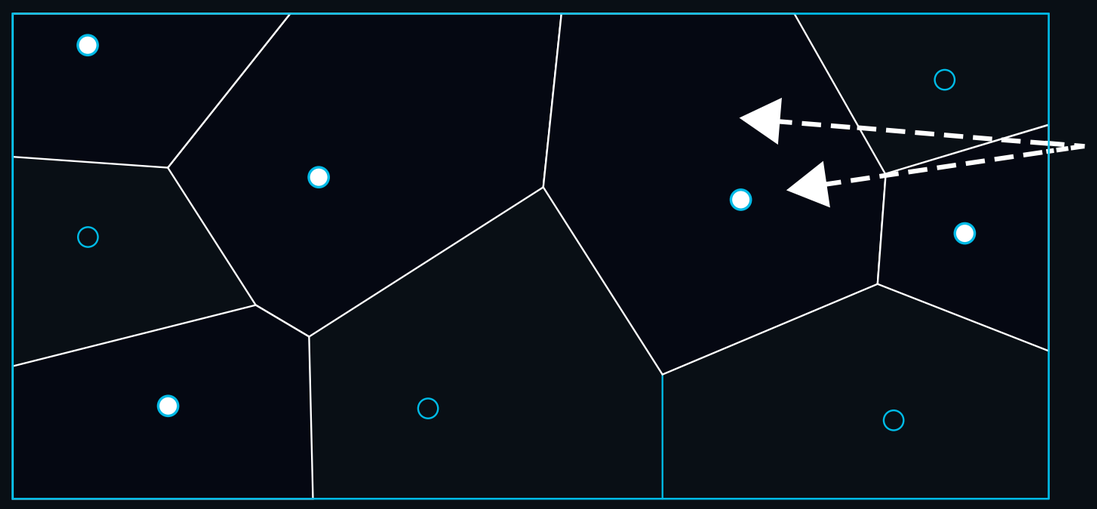

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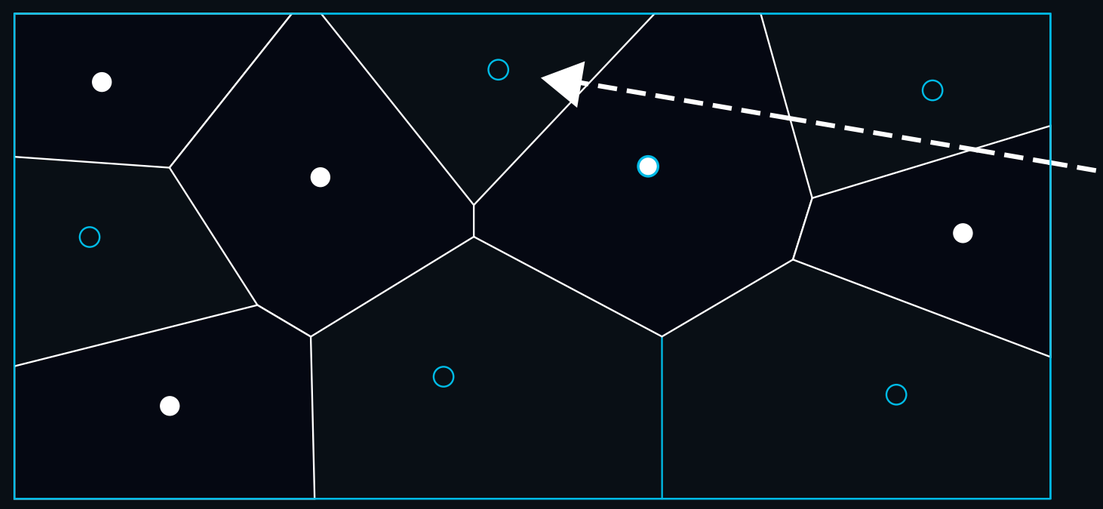
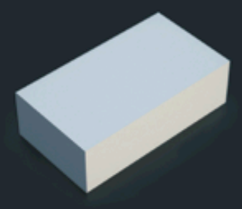


Child 21

Voronoi based genotype



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number-of-voronoi-sites: 1
lux: 5742.74
diffusion: 75064000.0

Generation:
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number-of-voronoi-sites: 137
lux: 2732.74
diffusion: 15033400.0

Generation:
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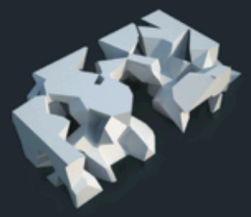
number-of-voronoi-sites: 138
lux: 1938.3
diffusion: 5979330.0



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lux: 2126.67
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Generation:
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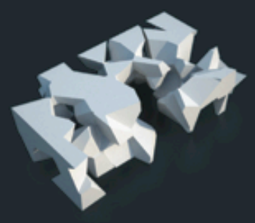
lux: 1348.48
diffusion: 3188570.0



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lux: 1639.84
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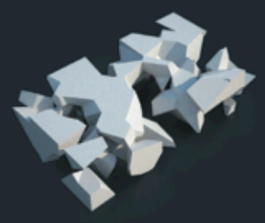

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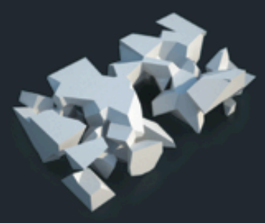
lux: 1341.28
diffusion: 3168130.0



Generation:
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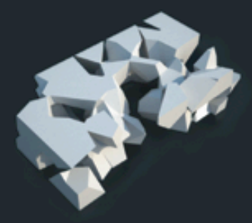
lux: 1341.28
diffusion: 3168130.0



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lux: 1048.58
diffusion: 2086120.0

Generation:
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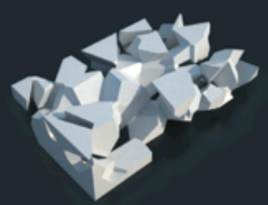
lux: 583.866
diffusion: 622635.0



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lux: 548.279
diffusion: 421003.0

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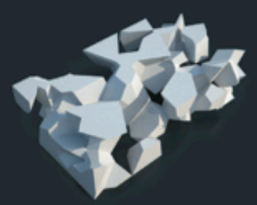

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lux: 537.854
diffusion: 564018.0

Generation:
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number-of-voronoi-sites: 151
lux: 475.226
diffusion: 366912.0

Generation:
129.175.5.169-Vor100-Gen083
number-of-voronoi-sites: 148
lux: 398.843
diffusion: 235898.0

Generation:
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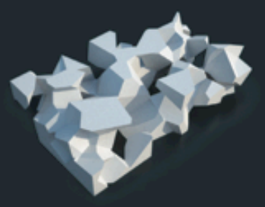
lux: 396.83
diffusion: 257885.0



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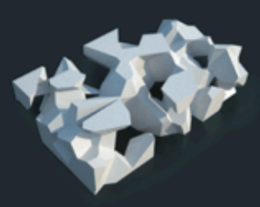
diffusion: 233378.0



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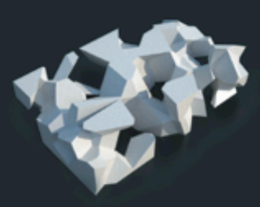
diffusion: 362789.0



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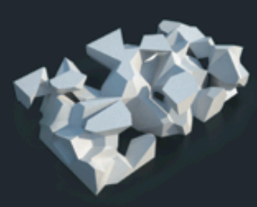

Generation:
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lux: 1469.05
diffusion: 3629510.0

Generation:
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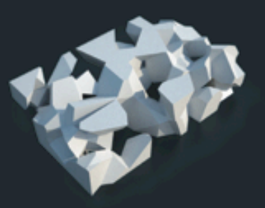
lux: 371.495
diffusion: 284374.0



Generation:
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lux: 338.34
diffusion: 242508.0

Generation:
129.175.5.169-Vor100-Gen110
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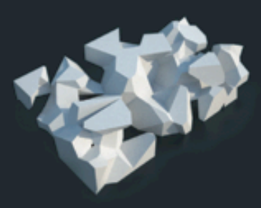
lux: 335.471
diffusion: 213176.0v



Generation:
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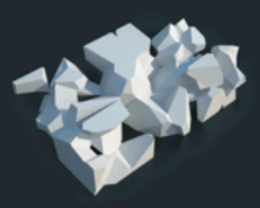
number-of-voronoi-sites: 134
lux: 1348.48
diffusion: 3188570.0



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lux: 360.623
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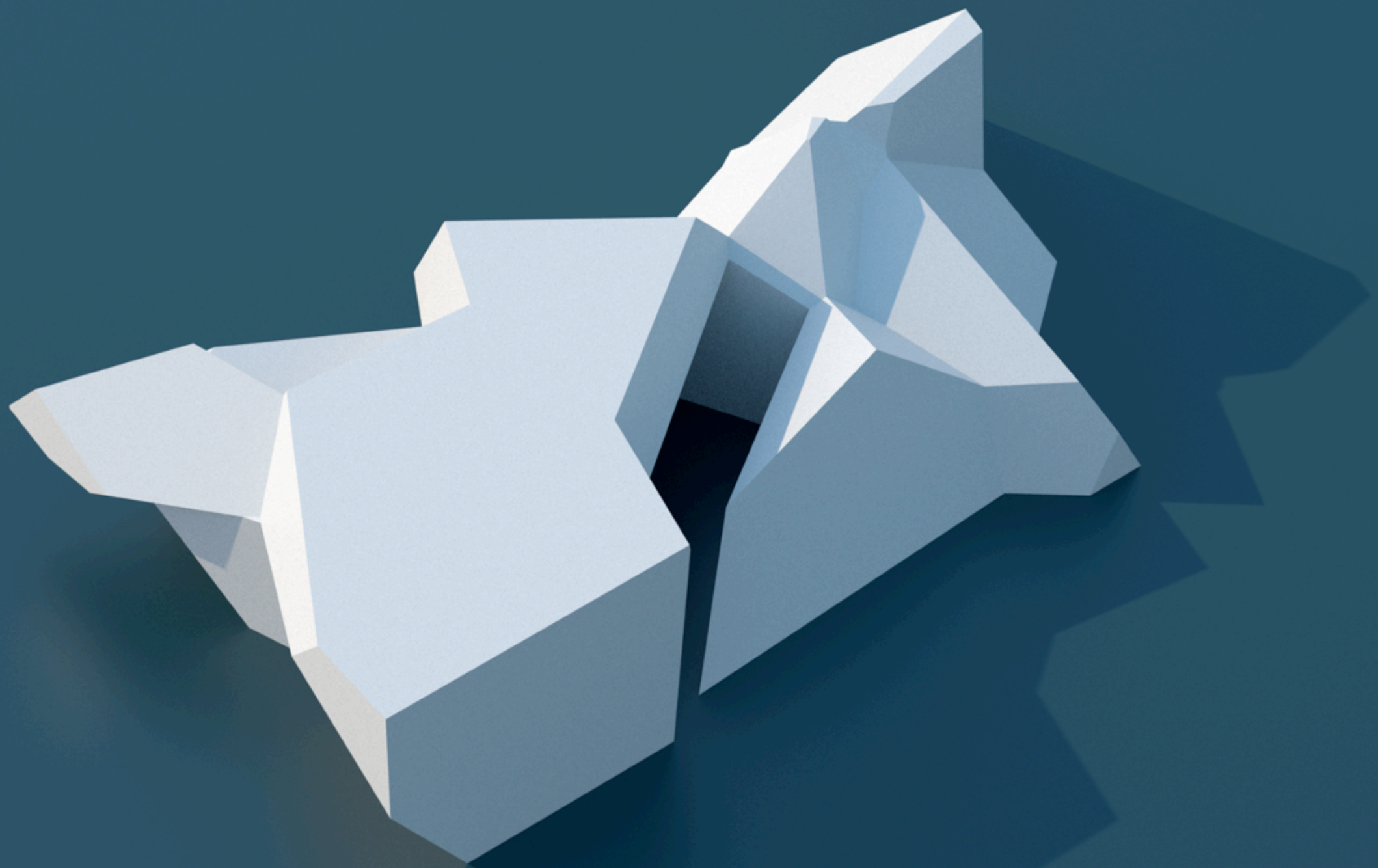
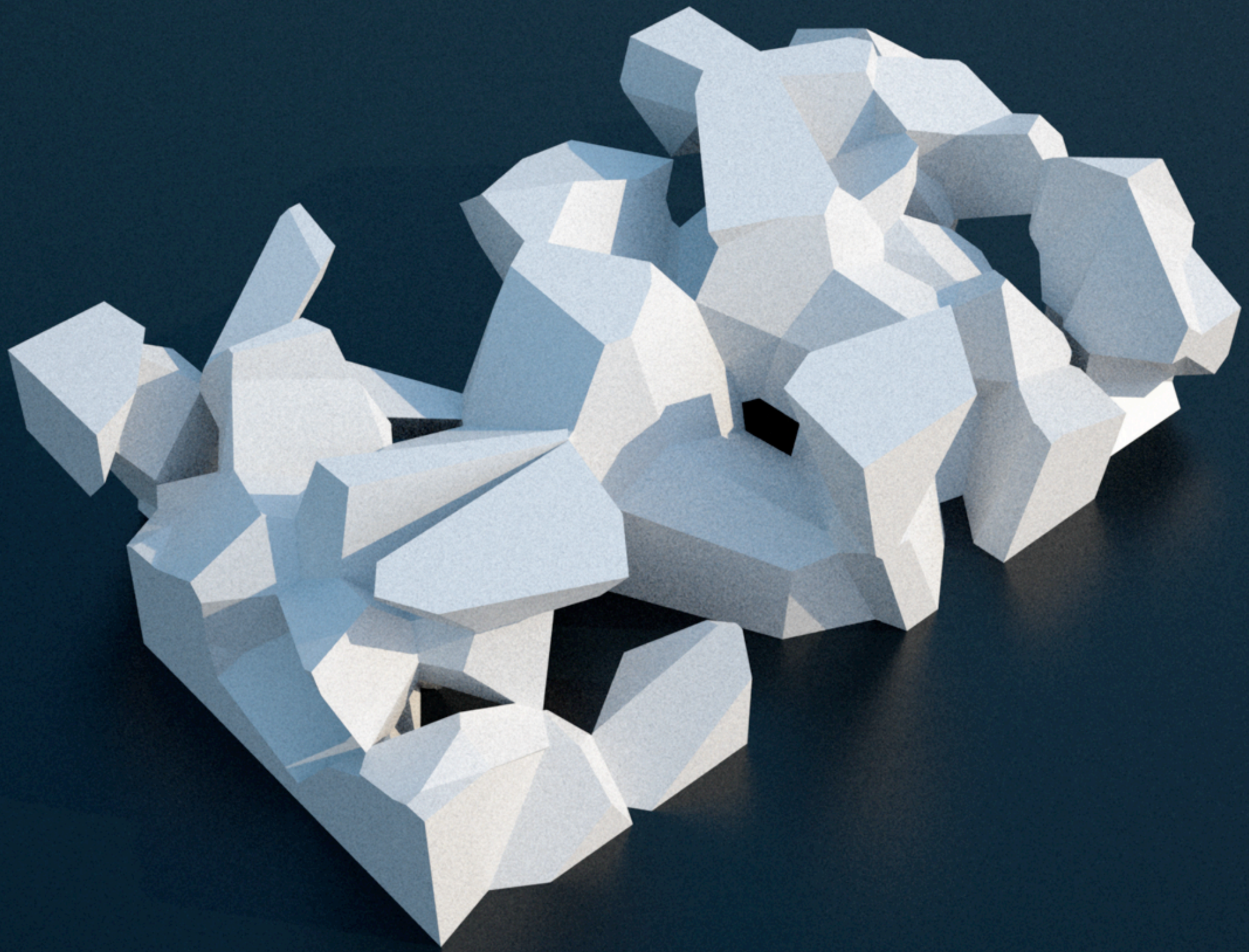
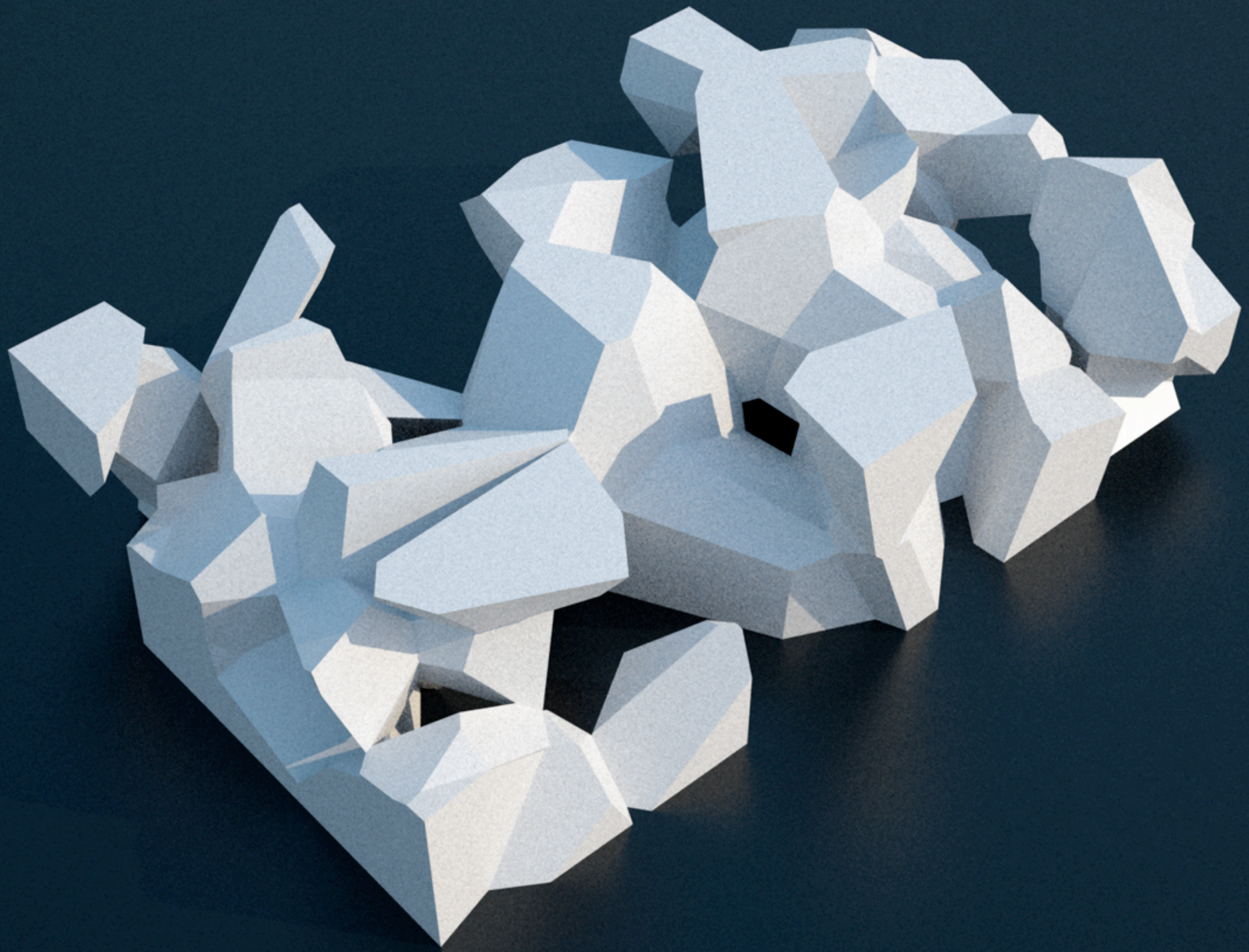


Individual with built from few cells

Individual with built from many cells



Individual from converged run



Individual from converged run

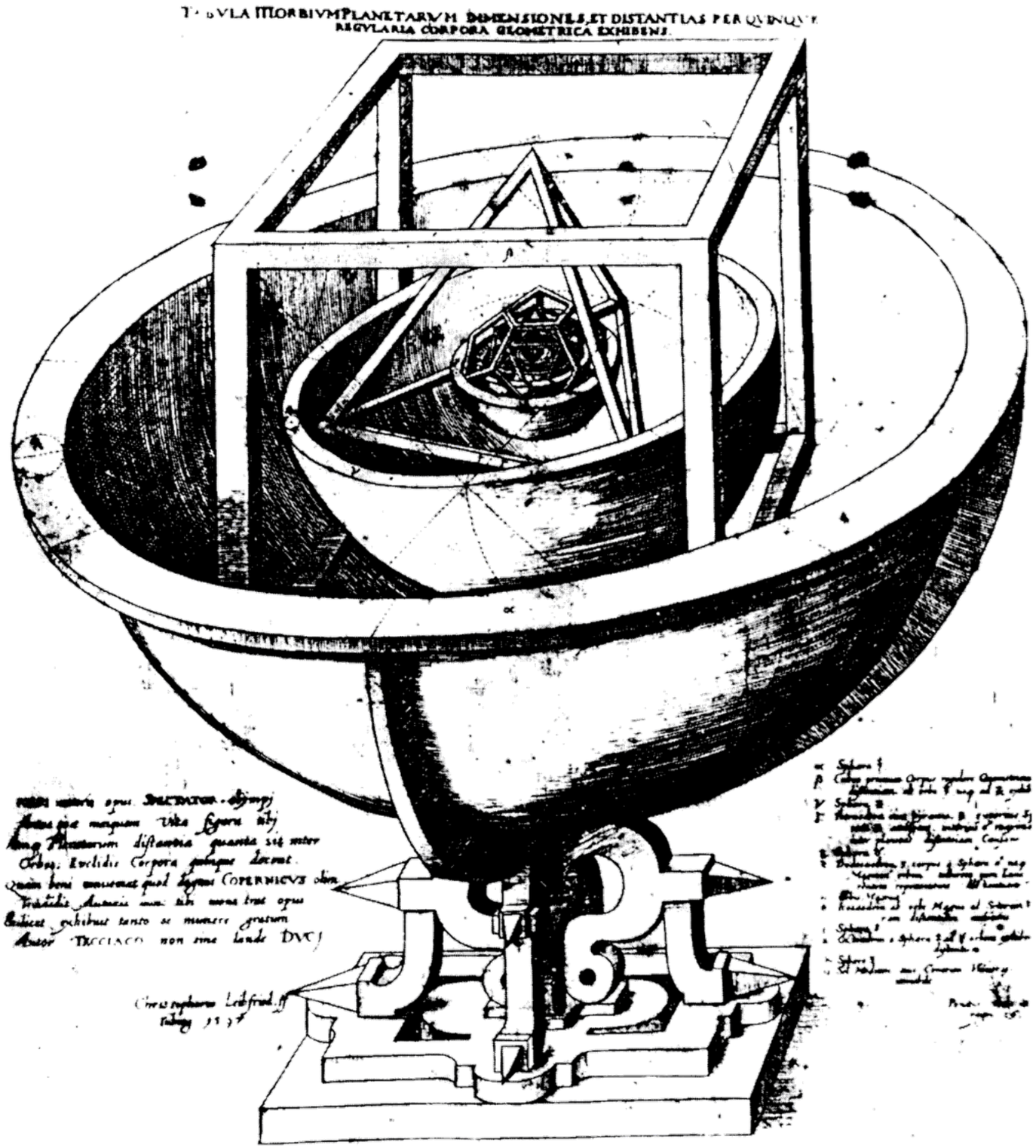
Design by Simulation

Sundial

Sundail

The chief aim of all investigations of the external world should be to discover the rational order and harmony which has been imposed on it by God and which He revealed to us in the language of mathematics

Johannes Kepler



Sacred geometry: Kepler's Mysterium Cosmographicum

Project: Sundail

Durer: Melencolia I

Project: Sundail

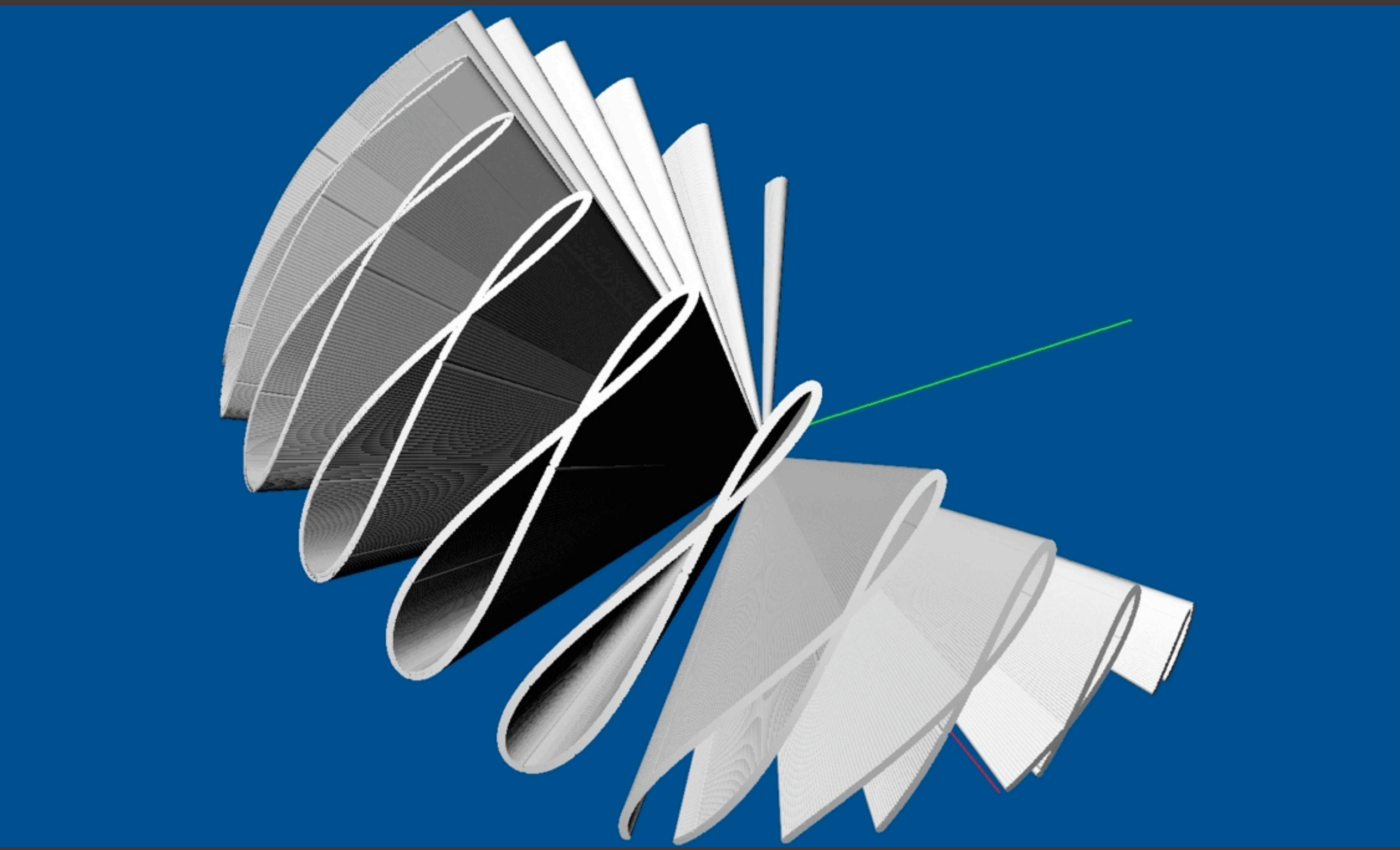
Stonehenge

Project: Sundail

G.Hawkins: Stonehenge a Neolithic Computer

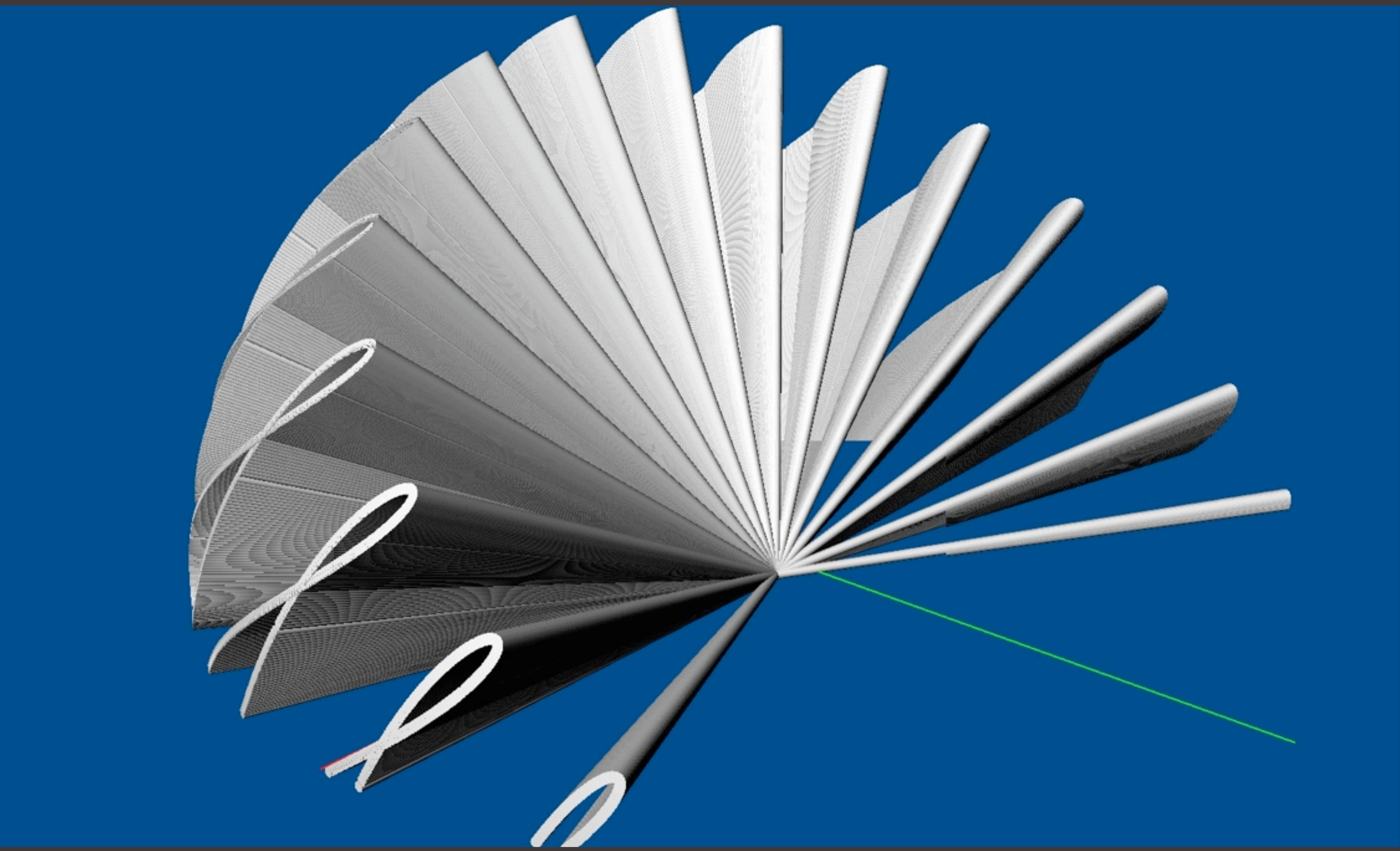
Nature, June 1964

Project: Sundail



All whole solar hours during a year in Paris

Project: Sundail



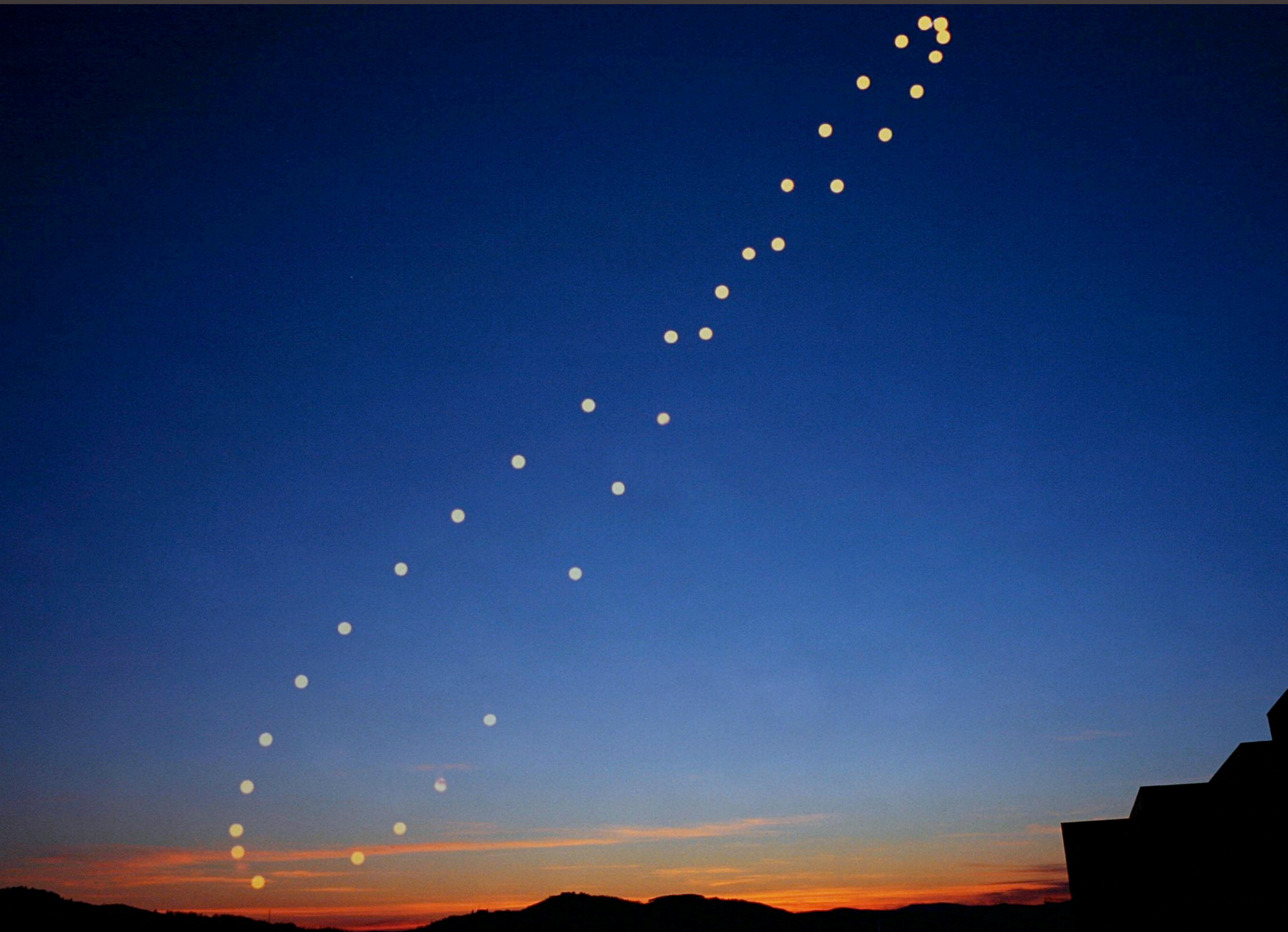
All whole solar hours during a year in Paris

Project: Sundail

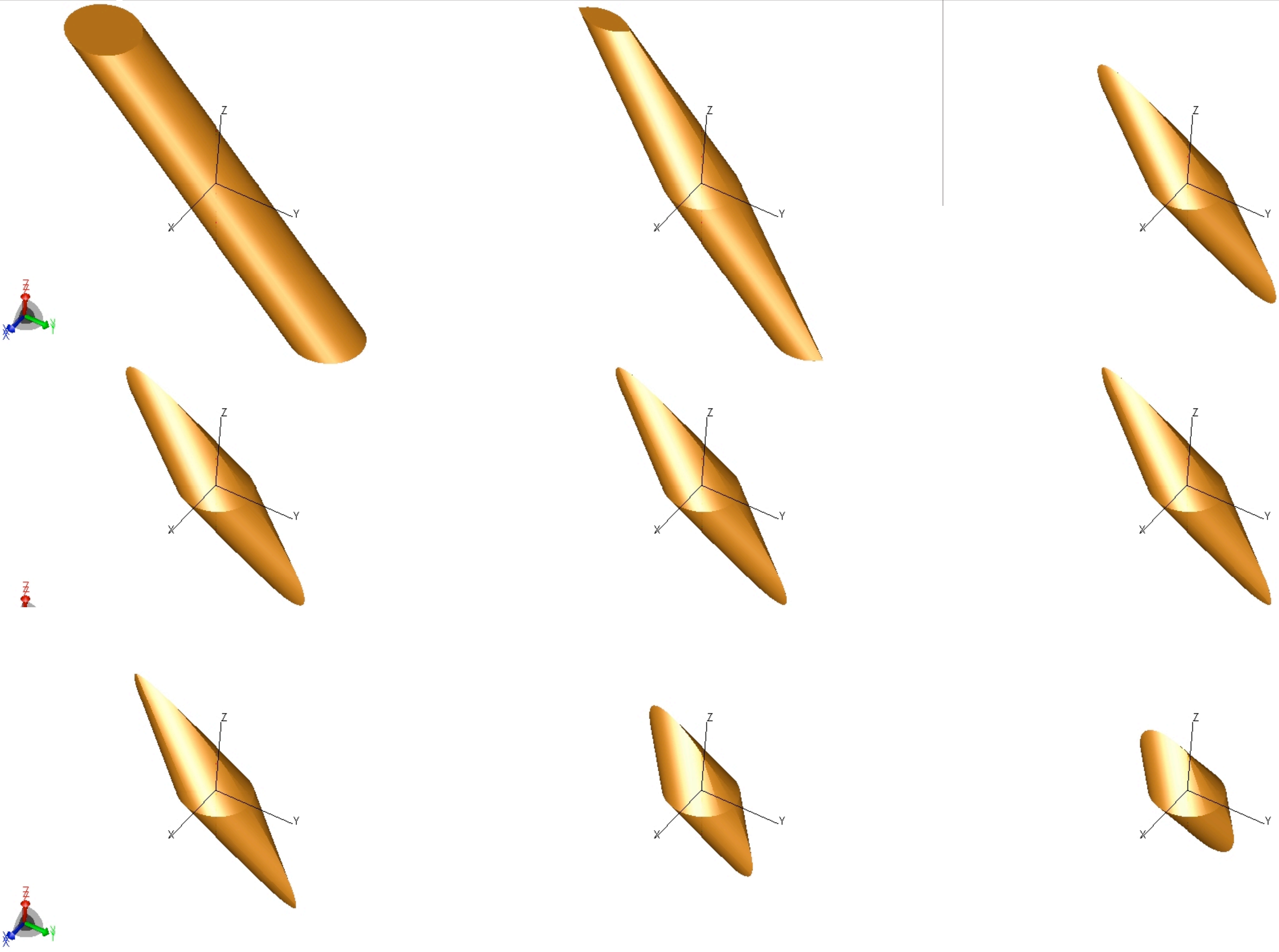
analemma

Project: Sundail

analemma



Project: Sundail



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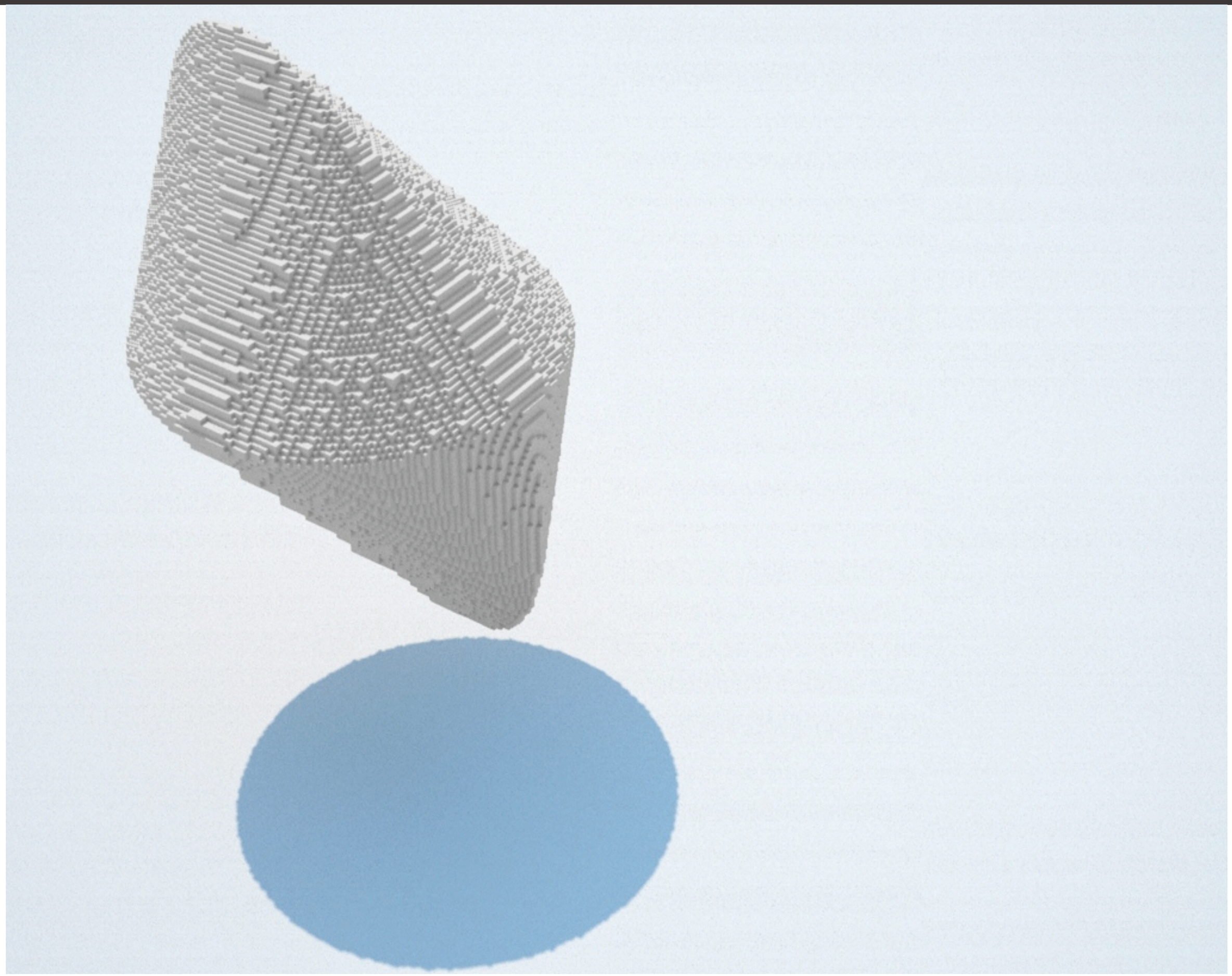

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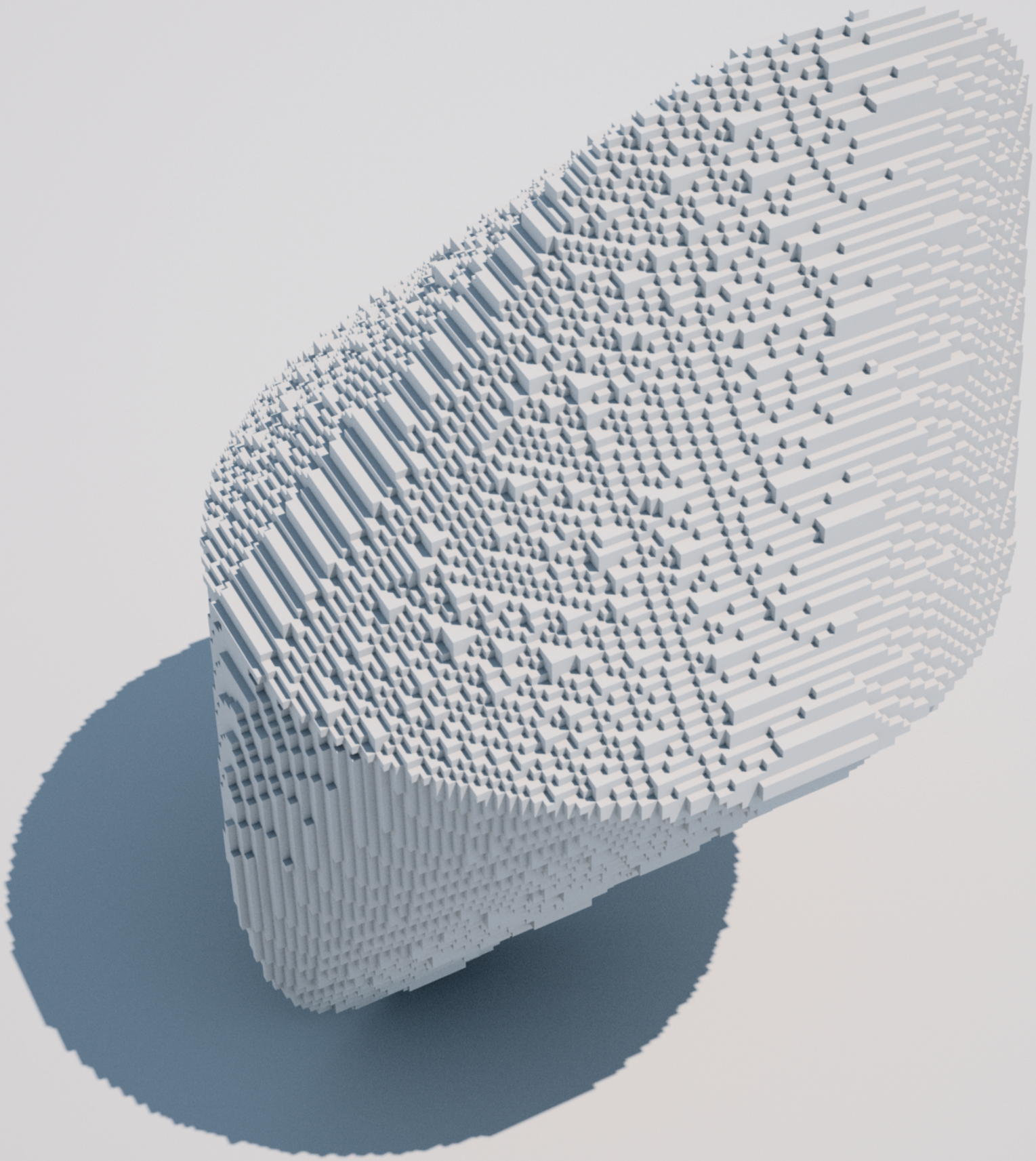
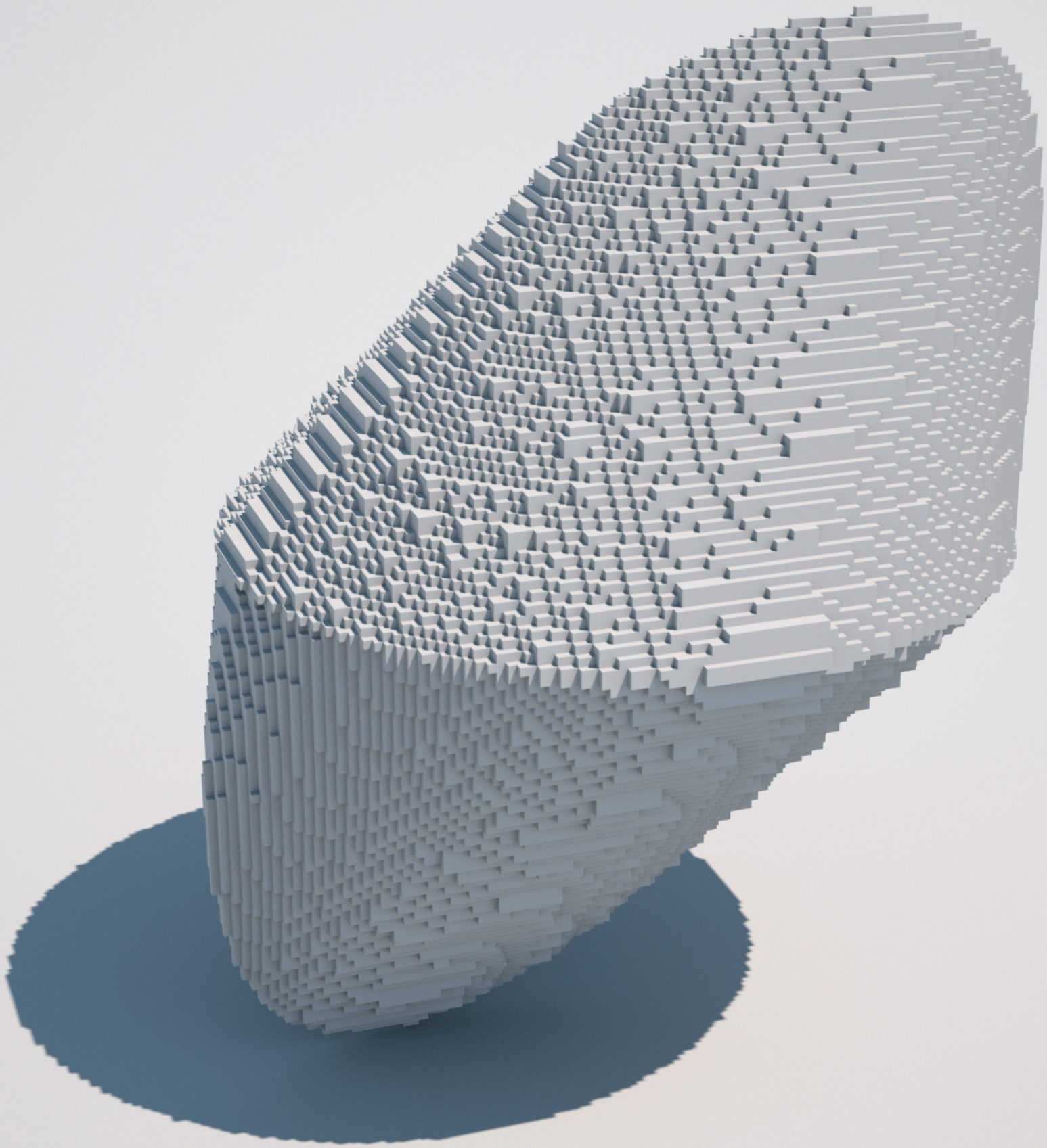
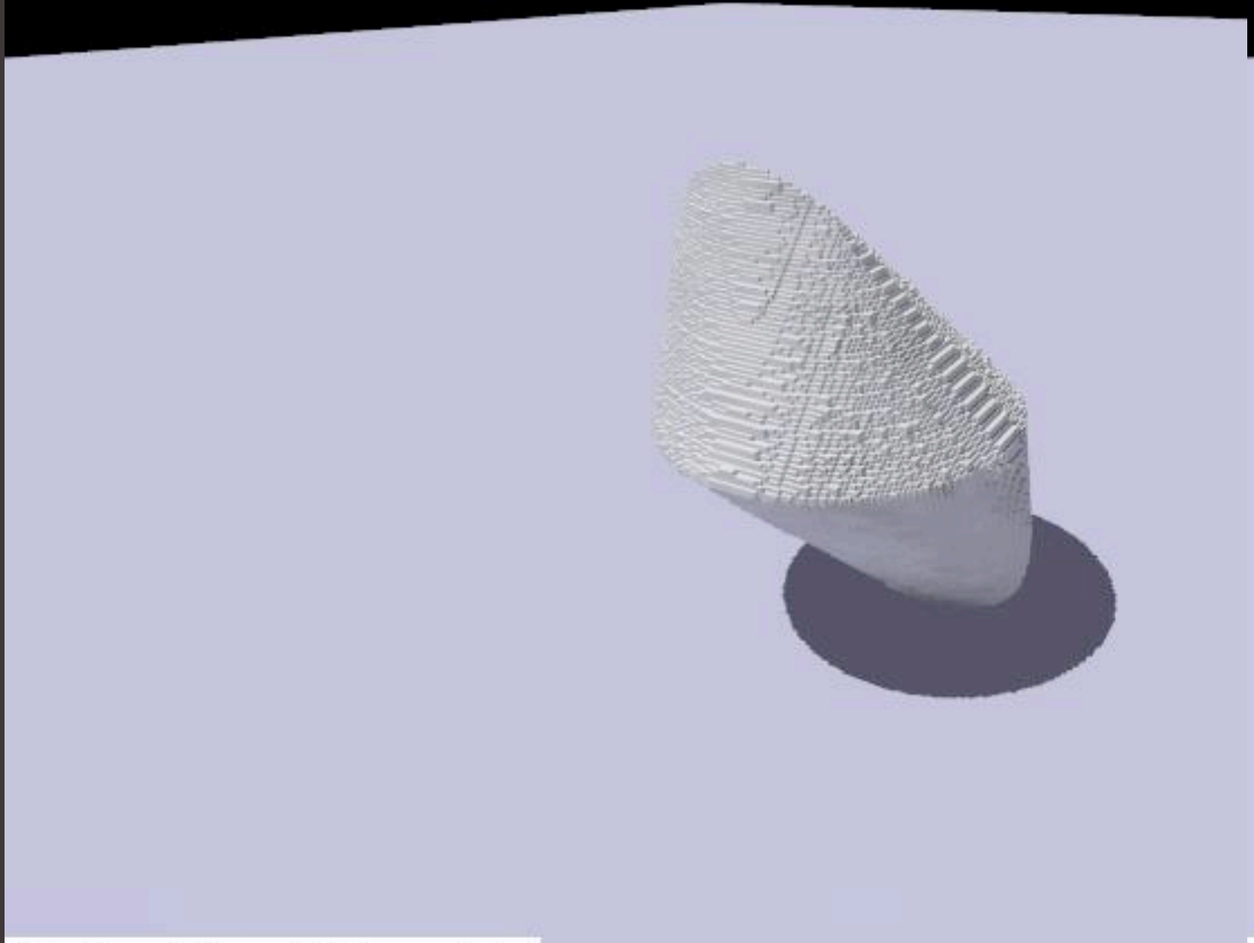


Project: Sundail

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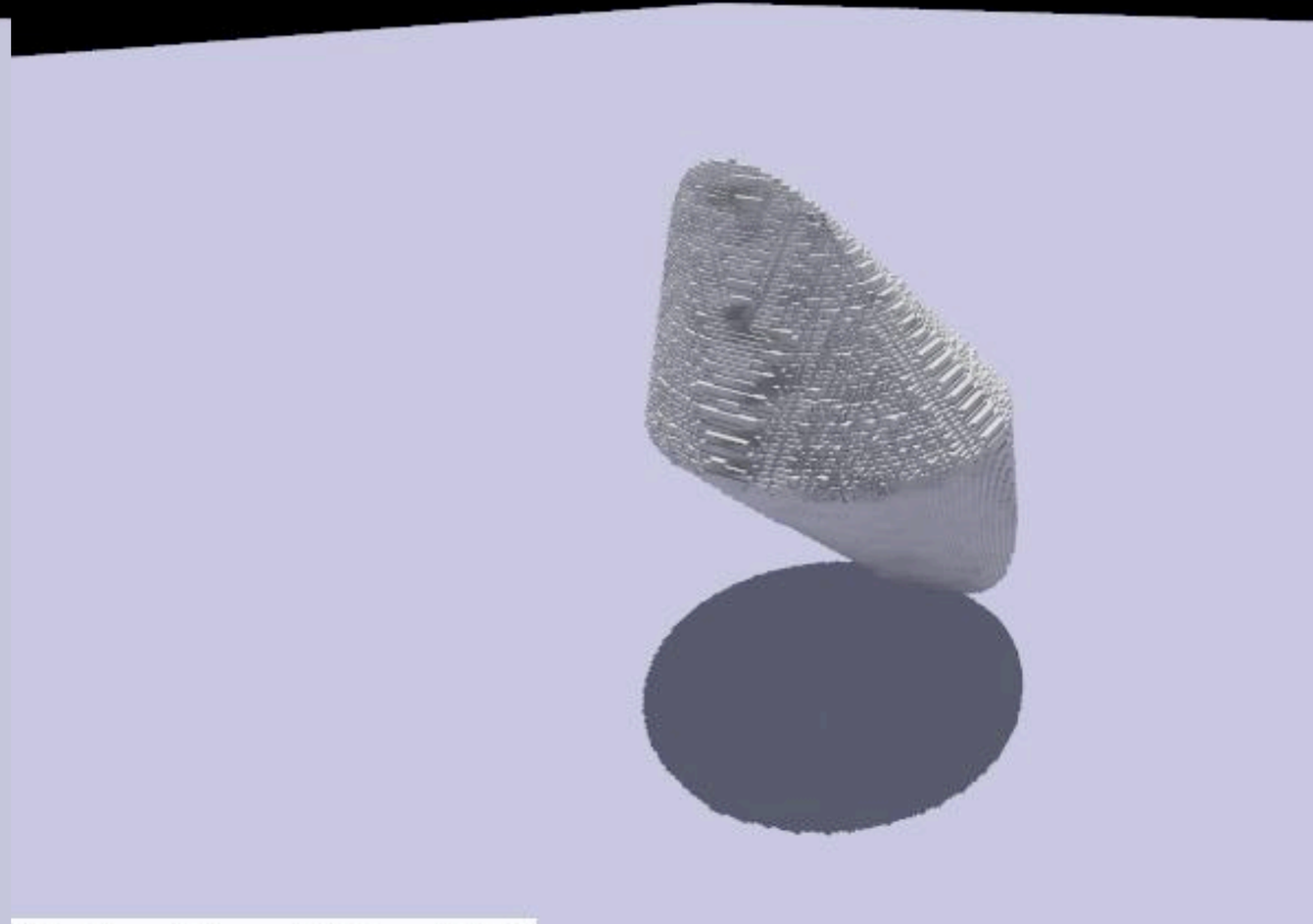
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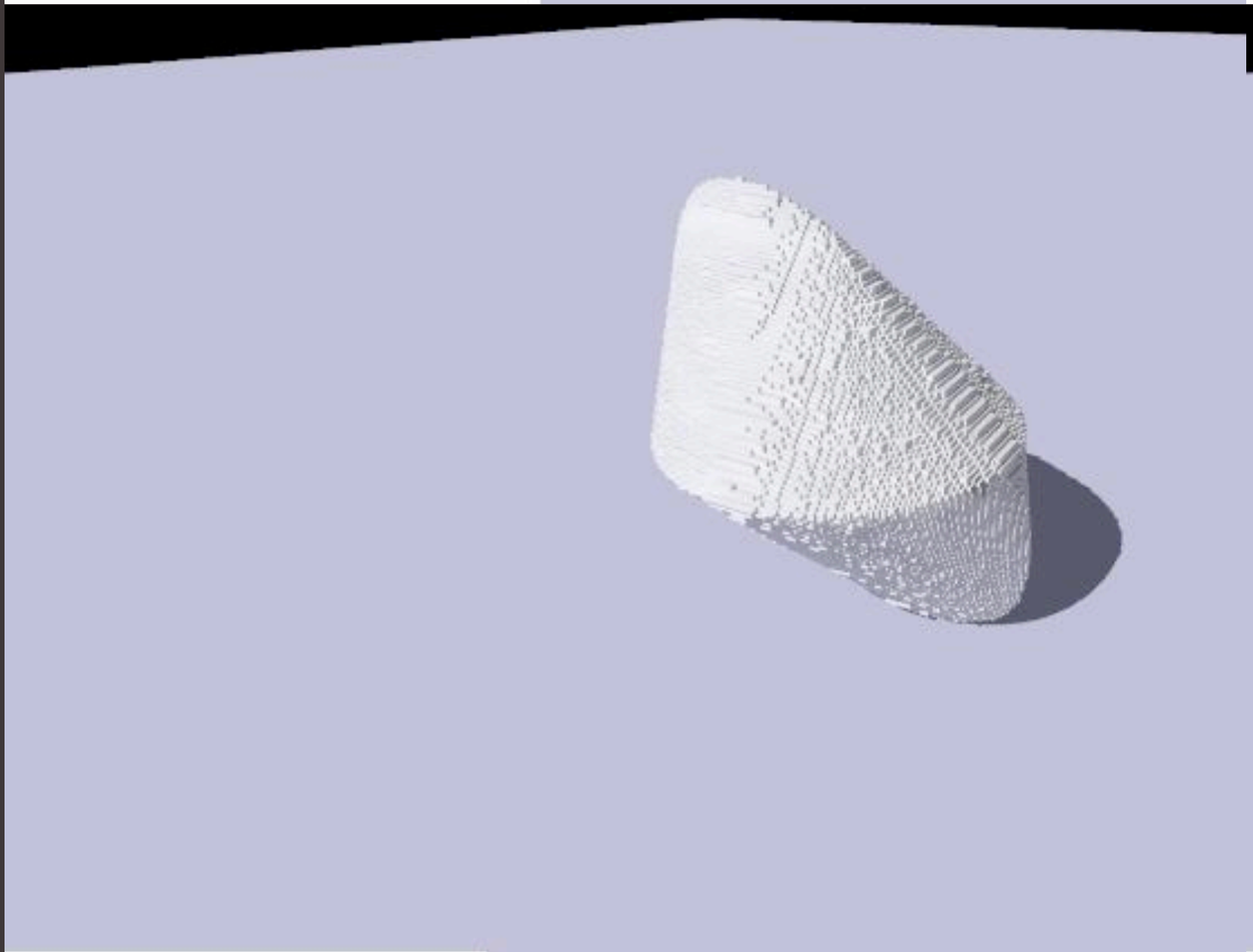
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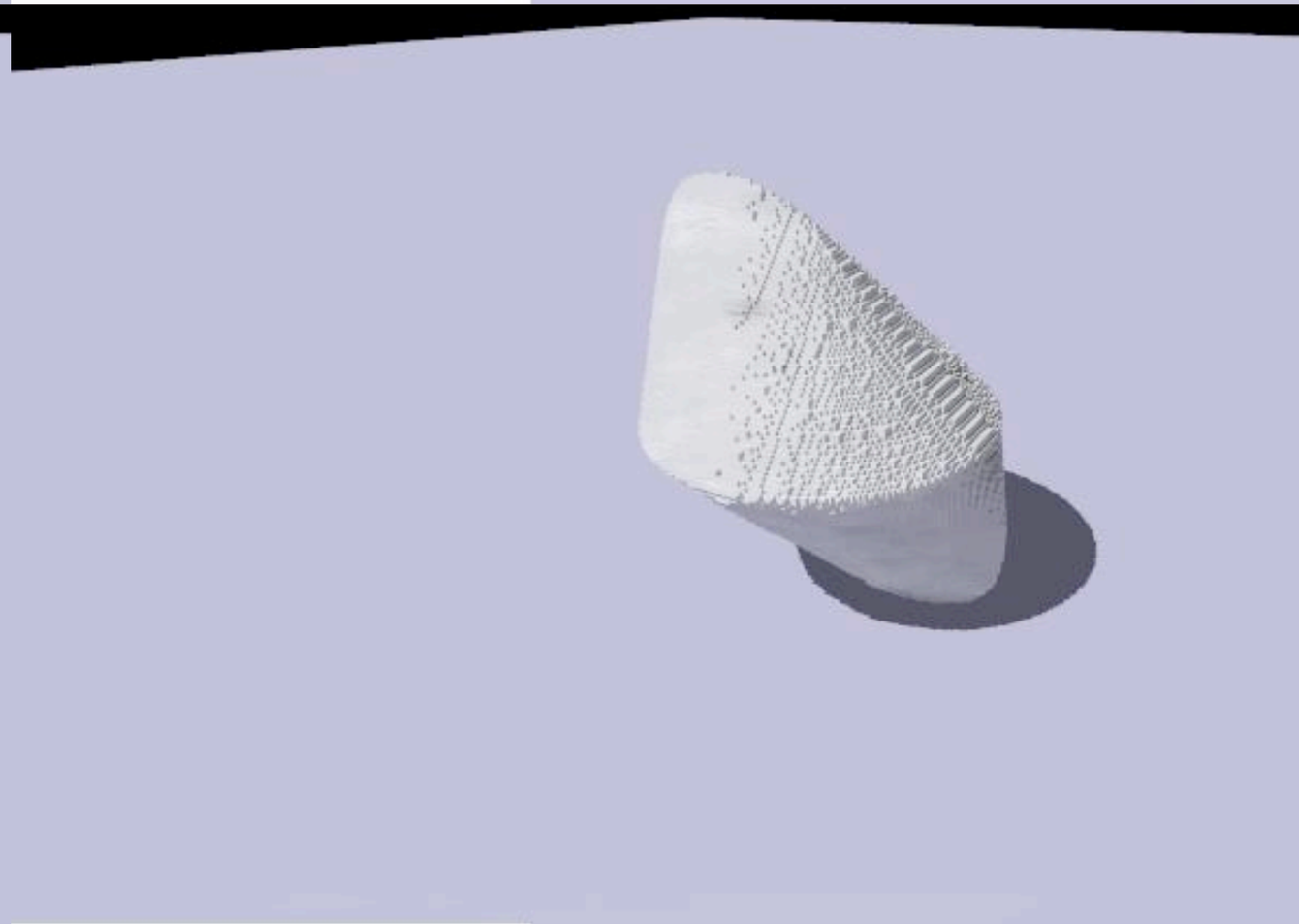
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